

Supplementary Table 2. Characters examined in the phylogenetic analyses that include morphological data. Most characters were taken as presented in either Harold and Weitzman (1996) or Harold (1998); the character numbers for characters used in their studies are presented as H&W or H, respectively, in the descriptions below. As noted in the Materials and Methods, the coding of some characters was changed. These were changed based on: (1) new sources noted below, (2) the examination of material or digital images (see material examined and character descriptions below), or (3) coding strategies for inapplicable character states that were developed by Strong and Lipscomb (1999). New characters are coded from Ahlstrom et al. (1984), Okiyama (2014), Moser et al. (1996), Richards (2005), and Fahay (2007).

1. (H&W152)—Median *adductor mandibulae* (A1 β): (0) single, undivided; (1) divided into two large muscles to primordial ligament and maxilla; (2) reduction of one or both A1 β sections.
2. (H8, H&W151)—Lateral *adductor mandibulae* (A2): (0) single, undivided; (1) subdivided into A2 α (dorsal) and A2 β (ventral) sections. Following the description in Harold, *Sternoptyx* is coded as state “0.”
3. (H35)—In species with a subdivided lateral *adductor mandibulae*, the ventral section is: (0) undivided; (1) divided into dorsal and ventral slips. Species without a subdivided lateral *adductor mandibulae* are coded as inapplicable.
4. (H20)—The ventral section of the lateral adductor mandibulae (A2 β), when present, inserts on connective tissue associated with the coronoid process: (0) without overlap; (1) with overlap. Species without divided A2 muscles were coded as inapplicable.

5. (H38)—A3 muscle of the *adductor mandibulae*: (0) not divided; (1) disjunct and displaced; (2) disjunct, but not displaced posteriorly.
6. (H1, H&W153)—*Extensor proprius pelvici*: (0) approximately horizontally oriented, overlying the *adductor superficialis*; (1) vertically oriented, markedly diverged from *adductor superficialis* and originating in connective tissue associated with one or two pleural ribs. Following the description of Harold (1998), *Sternoptyx* is coded as inapplicable because the element is missing. Its absence was not coded as an additional character because it was autapomorphic in our dataset.
7. (H29)—*Levator arcus palatini* is: (0) a single element; (1) divided.
8. (H30)—*Adductor arcus palatini*: (0) present; (1) absent.
9. (H21)—A branch of the *infracarinales medius* is: (0) undivided; (1) divided.
10. (H&W167)—Photophore type: (0) beta; (1) gamma; (2) alpha.
11. (H32)—Modified ‘pedomorphic’ beta photophores: (0) absent; (1) present. Species without beta photophores coded as inapplicable.
12. (H22, H&W156)—Photophore A cell configuration: (0) irregular; (1) radiating.
13. (H9, H&W154)—Metamorphosis of photophores: (0) rapid; (1) protracted.
14. (H7, H&W158)—Small photophores on the posterior portion of the lower jaw are: (0) absent; (1) present.
15. (H&W194)—Number of branchiostegal photophores (BR): (0) fewer than 14; (1) 14 or more.
16. (H10)—The IP photophores (ventral series of photophores, isthmus to pectoral fin) are: (0) present; (1) absent.

17. (H&W157)—Accessory photophore rows (e.g., LLP photophores): (0) present; (1) absent.
18. (H26, H&W199)—OA photophores (lateral series of photophores, opercle to anal fin origin): (0) present; (1) absent.
19. (H2)—Accessory horizontal photophore rows dorsal to the OA series: (0) present; (1) absent.
20. (H39)—Posterior inferior OP photophore (post-orbital photophores including opercular series): (0) present; (1) absent.
21. (H&W155)—Posterior PO photophore: (0) absent; (1) present.
22. (H&W201)—Serial photophore duct and lumen: (0) absent; (1) present.
23. (H3, H&W181)—The first pharyngobranchial (PB1) is: (0) cylindrical or slightly flared; (1) bifurcate.
24. (H37)—Toothplate on PB1: (0) absent; (1) present.
25. (H18)—The ventrolateral ramus of PB1, in taxa with a ventrally bifurcate PB1 is: (0) not elongate; (1) elongate. Species that lack the ventrally bifurcate PB1 were coded as inapplicable.
26. (H16)—The second pharyngobranchial (PB2): (0) reaches anterior to the second epibranchial; (1) articulates anteriorly with the medial, cartilaginous condyle of the second epibranchial (and lacks the rod-like anterior extension).
27. (H&W179)—PB2 dorsal uncinat e process: (0) nearly vertical to axis of horizontal shaft of bone; (1) forming an anterior, acute angle of between about 60 and 80 degrees.
28. (H&W184)—PB2 tooth plates: (0) absent or, if present, adhering loosely; (1) fused or adhering tightly.

29. (H&W178)—Third pharyngobranchial tooth plate: (0) highly dentigerous; (1) teeth reduced to about four or fewer or absent altogether.
30. (H15)—The dorsal portion of the tooth plate associated with the fourth pharyngobranchial (PB4): (0) does not have a median process; (1) does have a median process extending dorsally to the third pharyngobranchial.
31. (H25)—The anteromedian process of the UP5 tooth plate associated with PB4: (0) lacks a groove; (1) has a broad dorsal groove.
32. (H14)—The connective tissue connecting the fifth ceratobranchial to the ventrolateral surface of the cleithrum is: (0) a sheet of diffuse, less organized connective tissue; (1) a strong ligament.
33. (H&W180)—First epibranchial uncinat process: (0) distally cartilaginous, without a medial bony flange; (1) medial bony flange present, extending distally from cartilaginous process.
34. (H&W81)—The basihyal is: (0) present; (1) absent.
35. (H4, H&W183)—The basihyal is: (0) flattened, horizontally oriented, and has a dentigerous plate; (1) elongate, approximately vertically oriented, and lacking teeth. Harold (1998) noted that *Maurolicus*, *Sternoptyx*, and *Valenciennellus* lacked a basihyal, so they were coded as inapplicable.
36. (H&W197)—Basibranchials: (0) narrow; (1) broad.
37. (H45, H&W186)—Toothplates on second basibranchial: (0) present; (1) absent.
38. Toothplates on third basibranchial: (0) present; (1) absent. Coded based on text in Harold (1998) associated with his character 24.

39. (H24, H&W187)—Third basibranchial tooth plates: (0) lateral to basibranchial and superficial to tendon from third hypobranchial; (1) paired tooth plates closely adherent on dorsal surface. Taxa lacking a third basibranchial tooth plate are coded as inapplicable.
40. (H47, H&W188)—Toothplates on fourth basibranchial: (0) absent; (1) present.
41. (H&W162)—Gill raker development: (0) presence of full gill rakers along entire branchial arch; (1) gill rakers absent or restricted to near the ceratobranchial-epibranchial joint in adults.
42. (H&W182)—Number of posterior ceratohyal branchiostegals: (0) more than six; (1) six or fewer.
43. (H&W160)—Posterior four branchiostegals: (0) bases separated by space; (1) bases crowded together with at least the posterior two in, or nearly in, contact.
44. Vertebral counts: (0) fewer than 47; (1) more than 50. These were predominantly coded from Ahlstrom et al. (1984) and augmented with the other references noted above.
45. (H31)—Vertebral centra: (0) not notably elongate; (1) elongate.
46. (H40)—Neural arches: (0) well developed; (1) reduced and represented by the unfused open arches.
47. (H&W200)—Ossified accessory neural arch: (0) present; (1) absent.
48. (H&W196)—Epineurals fused to neural arches: (0) less than half the body length; (1) more than half the body length.
49. (H50)—Epineural and epipleural bones: (0) progressively displaced distally on spines from anterior to posterior; (1) associated with caudal vertebrae and are attached to the bases of the neural or haemal spines or to the centra.
50. (H48, H&W100)—Epipleurals: (0) present; (1) absent.

51. (H19, H&W193)—Parapophysis of first vertebra: (0) parapophysis of first vertebra larger than that of second but not elongate; (1) parapophysis one elongate and continuous with Baudelot's ligament; (2) parapophyses one and two subequal and short; (3) parapophyses one and two subequal, short, and the first associated with completely ossified Baudelot's ligament; (4) parapophysis one highly reduced. Character state two for the sternoptychids was not named in Harold (1998), but we believe this character is the same as Character 193 in Harold and Weitzman (1996), so we have added and coded all of the state names listed in that paper.
52. (H51)—Antermost rib posteriorly displaced to fourth vertebrae: (0) absent; (1) present.
53. (H5, H&W168)—The neural spine on the second preural centrum (NPU2): (0) short, roughly half the length of the spine immediately anterior; (1) fully developed spine. Harold (1998) noted that *Diplophos rebaini* had a well developed NPU2, but Harold (1998) coded the species as having a short NPU2. Given Harold's (1998) description, we coded this species as state "1."
54. (H&W192)—Configuration of ural centrum (PU2 + U1): (0) short, equidimensional; (1) elongate cylindrical.
55. (H44, H&W185/198)—Hypurals three and four: (0) separate elements; (1) fused into a plate. Characters 185 and 198 in Harold and Weitzman (1996) were effectively identical, but they were coded differently for *Vinciguerria*, so we have coded this taxon as having them fused following Nam et al. (2019).
56. (H&W190)—Number of epurals: (0) three; (1) one; (2) two.
57. (H28)—Rostral cartilage: (0) roughly spherical; (1) elongate transversely.

58. (H6, H&W189)—The nasal bones are: (0) small; (1) enlarged and overlying the lateral processes of the rostrodermethmoid.
59. (H&W169)—Palatovomerine ligament: (0) absent; (1) present.
60. (H&W177)—Size of medial jaw teeth: (0) various sizes; (1) mainly large, without small teeth interspersed.
61. (H13)—The premaxilla is: (0) not noticeably short; (1) short.
62. (H&W176)—Premaxillary symphysis shape: (0) ascending processes concave medially resulting in a median recess; (1) ascending processes with straight medial surfaces and in contact along their lengths.
63. (H27)—Premaxilla: (0) laterally expanded with highly convex ventral margin; (1) not laterally expanded.
64. (H33)—Paired ligaments extending from the anterolateral surface of the rostrodermethmoid to the anterolateral surface of the premaxilla: (0) absent; (1) present.
65. (H&W171)—Contralateral and ipsilateral branches of premaxillary-rostrodermethmoid ligament: (0) separate; (1) fused into a continuous sheet of connective tissue.
66. (H12)—Maxillary teeth: (0) have no distinguishable pattern of their teeth; (1) are short, straight, subequal, and closely spaced; (2) short straight teeth with three to four enlarged teeth distributed among the smaller teeth.
67. (H&W174)—Palatine shape: (0) posterior (entopterygoid) articular process similar in size to anterior (maxillary) process; (1) posterior process reduced and much smaller than anterior process.
68. (H11)—The posterior shaft of the palatine is: (0) short; (1) tapered distally, moderately elongate, and reaching at least a quarter length of the ectopterygoid.

69. (H&W170)—Anterior palatamaxillary ligament configuration: (0) lies ventral to lateral process of rostrodermethmoid; (1) looped over dorsal surface of lateral process of rostrodermethmoid.
70. (H&W175)—Anterior or lateral dentary tooth row: (0) short with only a few teeth near symphysis; (1) full row, lining outer margin of dentary.
71. (H&W172)—Entopterygoid: (0) well developed; (1) reduced or absent.
72. (H34)—Opercular condyle of the hyomandibula: (0) present and complete; (1) reduced.
73. (H36)—Dorsal limb of the hyomandibula: (0) short and vertically oriented; (1) flexed anterodorsally, producing a long oblique limb leading to the articulation with the pterotic.
74. (H&W173)—Hyomandibular spine: (0) short or moderately elongate and not contacting entopterygoid; (1) elongate and bound to the lateral surface of the entopterygoid by a ligament.
75. (H41)—Anus located: (0) immediately anterior to the anal-fin origin; (1) well anterior of the anal-fin origin, about midway between the bases of the anal and pelvic fins.
76. (H46, H&W161)—Pectoral-fin radials: (0) four radials; (1) three radials; (2) single large radial.
77. (H42)—Medial process of the pelvic bone: (0) subcylindrical to moderately conical; (1) greatly expanded distally.
78. (H17)—The medial radial of the pelvic fin: (0) is either a short posterior process or it lacks a process at all; (1) has an elongate posterior process adhering to, but not fused with, the ventral half of the medial fin ray.
79. (H&W191)—Lateral and medial plate-like processes of anterior or pubic process of the pelvic bone: (0) present; (1) absent.

80. (H23)—Anterior rays of the anal fin: (0) not elongate; (1) elongate.
81. (H49)—Adult dorsal-fin origin: (0) well in advance or of anal-fin origin; (1) close to a vertical relative to anal-fin origin.
82. Adipose fin: (0) present; (1) absent. This was predominantly coded from Grey (1964), Ahlstrom et al. (1984), and Harold (1998).
83. (H&W159)—Position of anal-fin origin: (0) below or anterior to dorsal fin origin; (1) posterior to dorsal fin origin.
84. (H&W163)—Pectoral-fin rays of larvae: (0) short; (1) elongate. Larvae were previously unknown for *Phosichthys* and *Triplophos*. We have coded *Phosichthys* based on images provided by Drs. Gretchen Grammer and Tony Miskiewicz, but we have removed the coding of larvae for *Triplophos* that was presented in Harold and Weitzman (1996) based on family-level coding of features from Ahlstrom et al. (1984) because the larvae of this genus are unknown.
85. (H&W164)—Gut of larvae: (0) contained by body wall; (1) trailing. Larvae were previously unknown for *Phosichthys* and *Triplophos*. We have removed the coding of larvae for both *Phosichthys* and *Triplophos* that were presented in Harold and Weitzman (1996) based on family-level coding of features from Ahlstrom et al. (1984) because the larvae of *Triplophos* is unknown, and the available images of *Phosichthys* (see character 84) were of insufficient quality to assess.
86. (H&W165)—Pigmentation pattern of larvae: (0) profuse pigmentation not present below lateral midline; (1) area below lateral midline profusely pigmented. Larvae were previously unknown for *Phosichthys* and *Triplophos*. We have coded *Phosichthys* and removed the coding of *Triplophos* (see character 84 for explanation).

87. (H&W166)—Cross-sectional shape of larvae: (0) ovate or elliptical; (1) circular. Larvae were previously unknown for *Phosichthys* and *Triplophos*. We have coded *Phosichthys* and removed the coding of *Triplophos* (see character 84 for explanation).
88. Prominent dorsal-surface pigmentation in postflexion larvae: (0) absent; (1) present.

Literature cited

Strong, E. E., and D. Lipscomb.

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